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TI Copper alloy lead frames for semiconductor packages, method for solder plating on lead frames, and semiconductor packages

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AB The lead frame materials have  $\leq$ 2000 residual 2nd phase particles of diameter  $\geq$ 1  $\mu\text{m}$  per 1  $\text{mm}^2$  after chemical polishing. The lead frames may comprise (A) 0.04-0.4 weight% Cr, 0.03-0.25 weight% Zr, and balance Cu, (B) Cr 0.04-0.4, Zr 0.03-0.25, Fe 0.1-1.8, Ti 0.1-0.8 weight%, and balance Cu, or (C) those microalloyed with 0.01-1.0 weight% (as total) Zn, Ni, Sn, In, Mn, P, Mg, and/or Si. Solder plating of the lead frames carried out by an electrochem. process in a bath containing  $\leq$ 25 g/L Sn ion and having bath temperature  $\leq$ 35° under relative speed (between the lead frame and bath solution) of  $\leq$ 2 m/s is also claimed. Semiconductor packages comprising the lead frames that are solder plated by the above stated process are also claimed. Formation of protrusions on lead frames by abnormal deposition is prevented.

## PATENT ABSTRACTS OF JAPAN

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### (54) LEAD FRAME MATERIAL FOR SEMICONDUCTOR PACKAGE, THE METHOD FOR SOLDERING THE LEAD FRAME MATERIAL AND SEMICONDUCTOR PACKAGE

#### (57)Abstract:

PROBLEM TO BE SOLVED: To prevent a protruding part from being generated on the surface of coating layer due to abnormal electrodeposits when lead frame is plated with solder.

SOLUTION: The lead frame consists of copper alloy, and is chemically polished as a pretreatment of solder coating. The number of second phasic particles which remained bigger than 1  $\mu\text{m}$  in diameter on the surface after the chemical polishing is to be less than 2000/mm<sup>2</sup>.

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## CLAIMS

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[Claim(s)]

[Claim 1] Leadframe material of the semiconductor package characterized by making or less [ 2000 //mm ] into two the number of the 2nd phase particles with a diameter of 1 micrometers or more which is the leadframe material to which solder plating is performed after consisting of a copper alloy and carrying out chemical-polishing processing of the front face, and remains on the front face of this leadframe material by said chemical-polishing processing.

[Claim 2] Leadframe material of the semiconductor package according to claim 1 to which an alloy presentation is characterized by the remainder consisting of Cu and an unescapable impurity Cr:0.04-0.4% and Zr:0.03-0.25% with mass percentage.

[Claim 3] Leadframe material of the semiconductor package according to claim 1 characterized by the remainder consisting of Cu and an unescapable impurity 1 as which the alloy presentation was chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4% and Zr:0.03-0.25% with mass percentage, or two sorts or more 0.01 to 1.0% in a total amount.

[Claim 4] Leadframe material of the semiconductor package according to claim 1 to which an alloy presentation is characterized by being the product made from a copper alloy which the remainder becomes from Cu and an unescapable impurity Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8% with mass percentage.

[Claim 5] Leadframe material of the semiconductor package according to claim 1 characterized by the remainder consisting of Cu and an unescapable impurity 1 as which the alloy presentation was chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si with mass percentage Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%, or two sorts or more 0.01 to 1.0% in a total amount.

[Claim 6] The solder plating approach to the leadframe material of the semiconductor package characterized by making into 2 or less m/sec the relative-velocity difference which it is [ difference ] the approach of carrying out solder plating of the leadframe material of a semiconductor package according to claim 1 to 5 by electroplating, and produces Sn ion concentration under 35 degrees C or less and plating bath for the temperature of a plating bath between 25 or less g/L, leadframe material, and plating liquid.

[Claim 7] The solder plating approach to the leadframe material of the semiconductor package according to claim 6 characterized by using the energization pattern in electroplating as the pattern which repeats energization of 20 or less secs, and an energization halt of 0.02 or more secs by turns.

[Claim 8] The semiconductor package characterized by coming to incorporate the leadframe material to which solder plating was performed by the solder plating approach according to claim 6 or 7.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the approach of performing solder plating to the leadframe material and leadframe material of a semiconductor package, and the semiconductor package in which it comes to include the leadframe material to which solder plating was performed.

[0002]

[Description of the Prior Art] The further miniaturization, thin-shape-izing, and multi-functionalization are demanded of electronic equipment, such as a portable personal computer with spread remarkable in recent years, and a cellular phone. In order to realize it, a miniaturization, high integration, and those high density mounting technology of electronic parts are needed. Since the semiconductor package which makes the nucleus of electronic parts is excellent in economical efficiency and mass-production nature, its plastic package which carried out the mold of the circuitry components, such as a semi-conductor, resistance, and a capacitor, with thermosetting resin with the leadframe is in use. SOP (small outline package), QFP (quad flat package), etc. the plastic package of whose is a surface mount device are becoming in use. Since especially QFP can respond to the increment in an I/O signal, there is much need. Moreover, CSP (chip-size package) of what promoted thin shape-ization called TSOP (Singh quad flat package) with a thickness of about 1mm, and various gestalten brought close to the size of a semiconductor chip as much as possible is also in the limelight.

[0003] By the way, the product made from a Fe-nickel system alloy to which the leadframe for energization used for various kinds of above-mentioned semiconductor packages mainly makes a nickel-Fe alloy representation 42% (mass percentage: only indicate it as % below), or the product made from a copper alloy was used. However, in recent years, compared with a Fe-nickel system alloy, conductivity is high, and the product made from a copper alloy is increasing from the field advantageous to the correspondence to the formation of high temperature stripping of a semiconductor package, or improvement in the speed of signal transduction. As the copper alloy, many precipitation-hardening mold copper alloys, such as a Cu-Fe-P system which combines high intensity and high conductivity, a Cu-nickel-Si system, a Cu-Cr system, and a Cu-Cr-Zr system, are used.

[0004] Now, in the production process of a semiconductor package, after performing resin mold, generally forming a plating layer in the front face of the outer lead (it is also called a lead terminal) which is the part which has come out of the resin mold of a leadframe by electroplating is performed. The plating processing to an outer lead is aimed at making easy corrosion resistance improvement and mounting to a substrate etc. As a plating ingredient, solder with good solder wettability is usually used. Although the melting point becomes the lowest with 183 degrees C and becomes good [ wettability ] in the eutectic presentation near 63%Sn-37%Pb, when an outer lead is drawn through, in the continuing trimming process, the degree of hardness which is extent which solder waste does not generate is required for solder. Generally from the viewpoint, the solder whose content of Sn is 80 - 90% is used.

[0005] If in charge of electroplating an outer lead, in advance of actual plating processing, chemical polishing removes the oxidizing zone of dozens produced on the surface of the outer lead with heating at the time of carrying out the cure of the resin mold - about 100nm of numbers. As a plating bath used for electroplating, solder plating baths, such as an alkanol sulfonic-acid bath, an alkane sulfonic-acid bath, and a HOUFUTSU-ized bath, are used. The rack method for hanging an outer lead on a rack, being immersed during the plating bath of a plating tub the whole rack as electroplating, and giving electroplating, the conveying method for giving electroplating, while conveying during a plating bath using the plating tub equipped with the loader and

the unloader, etc. are adopted. After the semiconductor package by which solder plating was performed to the outer lead trims an outer lead, a substrate is equipped with it at the reflow process at the time of mounting.

[0006]

[Problem(s) to be Solved by the Invention] By the way, when electroplating was given as mentioned above, there was a case where the defect dotted with the abnormality electrodeposition object of the letter of a projection on the surface of an outer lead arose, conventionally. It was presupposed that a deposit of solder was originated in being generated locally, and also when this projection deposited in the shape of resin and die length of hundreds of micrometers was reached, there was. The projection by deposit of such an abnormality electrodeposition object was what causes the short circuit of an outer lead, and the fault of incorrect actuation of the circuit further accompanying it. Recently, it can be said that there are some which made the pitch of an outer lead small to about 150 micrometers, and raised packaging density in order to meet the demand of a miniaturization of a semiconductor package, therefore the above-mentioned fault is in the situation which is easy to generate increasingly.

[0007] Therefore, this invention aims at the following matters.

\*\* Offer the leadframe material by which generating of the projection by the abnormality electrodeposition object is prevented.

\*\* In carrying out solder plating of the leadframe material, offer the solder plating approach that generating of the projection by the abnormality electrodeposition object is prevented.

\*\* There is no projection by the abnormality electrodeposition object in the leadframe material by which solder plating was carried out, and therefore the short circuit by projection is prevented, and offer the semiconductor package by which the improvement in packaging density, as a result a large miniaturization are attained as a result.

[0008]

[Means for Solving the Problem] As a result of considering wholeheartedly generating of an abnormality electrodeposition object, presentation of leadframe material, and relation with solder plating conditions, this invention person etc. finds out the terms and conditions which an abnormality electrodeposition object does not generate, and came to complete this invention. Below, the concrete approach is explained.

[0009] (1) The precipitation-hardening mold copper alloy which mentioned above the leadframe material of pretreatment this invention by chemical polishing of leadframe material also a copper alloy and in it is used suitably. Such a copper alloy has many which contain in an in-house the 2nd phase particle produced according to a deposit or crystallization. As the main 2nd phase particles, Cr and a Cu-Zr compound are mentioned by Cr and the Cu-Cr-Zr system copper alloy with a nickel-Si compound and a Cu-Cr system copper alloy with a Cu-Fe-P system copper alloy at a Fe-P compound and a Cu-nickel-Si system copper alloy. Since it is hard to dissolve in chemical-polishing liquid rather than the copper of a host phase in the case of chemical polishing usually performed as pretreatment of solder plating, these particles may remain in the shape of a projection on the front face of leadframe material. When this serves as an origin when an electrodeposited object deposits and lessened [ therefore ] the 2nd phase particle, what the deposit of an electrodeposited object will be suppressed for was assumed.

[0010] Then, this invention person etc. found out that a deposit of an electrodeposited object was suppressed, when the number and the relation of a residual condition of the 2nd phase particle after chemical polishing were investigated and the number of the 2nd phase particles with a diameter of 1 micrometers or more which remains on the front face after chemical polishing was two or less [ 2000 //mm ]. Therefore, the leadframe material of this invention is leadframe material to which solder plating is performed, after consisting of a copper alloy and carrying out chemical-polishing processing of the front face, and it is characterized by making or less [ 2000 //mm ] into two the number of the 2nd phase particles with a diameter of 1 micrometers or more which remains on the front face of this leadframe material by chemical-polishing processing.

[0011] The mixed liquor of a common peroxide and an acid is used as chemical-polishing liquid used for chemical polishing. A peroxide has the operation which separates oxygen ion and oxidizes the copper of a base material, and, on the other hand, an acid has the operation which dissolves an oxide. Therefore, the surface of a copper alloy is removable with these coexistence. As a peroxide, persulfate, such as ammonium persulfate besides hydrogen peroxide solution, is used. Moreover, what has copper solubility high as an acid is desirable, for example, a sulfuric acid, a nitric acid, a hydrochloric-acid HOUFUTSU acid, sulfamic acid, etc. are used.

[0012] (2) Explain the convention about the presentation of leadframe material, next the presentation of the

leadframe material of this invention, and its basis. (a) A Cu-Cr-Zr system copper alloy \*\* alloy presentation is characterized by the remainder consisting of Cu and an unescapable impurity Cr:0.04-0.4% (% said here being mass percentage and being altogether the same below) and Zr:0.03-0.25%.

[0013] If aging treatment is performed after Cr carries out solution treatment of the alloy, it will deposit in a host phase and will raise reinforcement. However, if the content of Cr cannot acquire the desired improvement effectiveness in on the strength at less than 0.04% but exceeds 0.4% on the other hand, big and rough Cr will remain in a host phase, and solder plating nature will deteriorate. Therefore, the content of Cr is made into 0.04 - 0.4%, and is desirable especially within the limits of this. [ 0.25% or less of ] Moreover, by performing aging treatment, Zr forms Cu and a compound, deposits in a base material, and raises reinforcement. However, if the content of Zr cannot acquire the desired improvement effectiveness in on the strength at less than 0.03% but exceeds 0.25% on the other hand, Zr which is not dissolved [ big and rough ] will remain in a host phase, and solder plating nature will deteriorate. Therefore, the content of Zr is made into 0.03 - 0.25%, and is desirable especially within the limits of this. [ 0.15% or less of ]

[0014] \*\* It is characterized by the remainder consisting of Cu and an unescapable impurity 1 as which the alloy presentation was chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4% and Zr:0.03-0.25%, or two sorts or more 0.01 to 1.0% in a total amount.

[0015] The reason for a convention of the content of Cr and Zr is based on the above-mentioned (a) \*\*. Each of Zn, nickel, Sn, In, Mn, P, Mg, and Si raises reinforcement mainly by solid solution strengthening, without reducing the conductivity of an alloy greatly. Therefore, any one sort or two sorts or more are added. However, if the content cannot acquire the improvement effectiveness in on the strength of a request at a total amount at less than 0.01% but exceeds 1.0% on the other hand, conductivity will fall remarkably. Therefore, the total amount was made into 0.01 - 1.0%.

[0016] (b) A Cu-Cr-Zr-Fe-Ti system copper alloy \*\* alloy presentation is characterized by being the product made from a copper alloy which the remainder becomes from Cu and an unescapable impurity Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%.

[0017] The reason for a convention of the content of Cr and Zr is based on the above-mentioned (a) \*\*. By performing aging treatment, Fe and Ti form an intermetallic compound with that of Fe and Ti into a host phase, and raise reinforcement more by this. However, both contents cannot acquire the desired improvement effectiveness in on the strength at less than 0.1%. On the other hand, the big and rough inclusion with which the content of Fe will use Fe and Ti as a principal component if the content of 1.8% and Ti exceeds 0.8% remains, and solder plating nature is checked. Therefore, the content of Fe is made into 0.1 - 1.8%, and is desirable especially within the limits of this. [ 1.4% or less of ] Moreover, the content of Ti is made into 0.1 - 0.8%, and is desirable especially within the limits of this. [ 0.4% or less of ]

[0018] \*\* It is characterized by the remainder consisting of Cu and an unescapable impurity 1 as which the alloy presentation was chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%, or two sorts or more 0.01 to 1.0% in a total amount.

[0019] The reason for a convention of the content of Cr and Zr is based on the above-mentioned (a) \*\*. Moreover, the reason for a convention of the content of Fe and Ti is based on the above-mentioned (b) \*\*. Furthermore, 1 chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si or the reason for a convention of two or more sorts of total amounts is based on the above-mentioned (a) \*\*.

[0020] (3) In case the solder plating approach solder plating to leadframe material is performed, the temperature, the metal ion concentration, and the stirring conditions of a plating bath influence a deposit of an abnormality electrodeposition object and growth. The diffusion layer which the metal ion was consumed by the deposit reaction near the leadframe material (i.e., cathode near), and became low [ ion concentration ] in the condition of having been immersed during the plating bath in leadframe material is generating. For this reason, growth of a plating layer is influenced by the rate of the metal ion which passes this diffusion layer. Since the diffusion length of a metal ion required for generation of the electrodeposited object in the part will become short once an electrodeposited object deposits in the shape of a projection, the occurrence frequency of an electrodeposited object will increase and an electrodeposited object will grow. In order to suppress this growth, the means which lowers the migration rate of ion, the means which lowers metal ion concentration, and a means to restrict the strength [ a plating bath ] of churning and to thicken a diffusion layer are mentioned by lowering the temperature of a plating bath.

[0021] this invention person etc. found out that growth of an electrodeposited object was suppressed, when

various conditions of these means were changed and investigated and the relative-velocity difference of the leadframe material and plating liquid which the temperature of a plating bath produces when Sn ion concentration under 35 degrees C or less and plating bath makes a plating bath stir below 25g / L fulfilled the terms and conditions of 2 or less m/sec. Therefore, the solder plating approach for the leadframe material of the semiconductor package of this invention is characterized by making into 2 or less m/sec the relative-velocity difference which produces Sn ion concentration under 35 degrees C or less and plating bath for the temperature of a plating bath between 25 or less g/L, leadframe material, and plating liquid as conditions for electroplating. In addition, about the temperature of a plating bath, 25 degrees C or less are more desirable, below 20g / L are more desirable about Sn ion concentration, and 1 m/sec is more desirable about a relative-velocity difference. [0022] Moreover, in the solder plating approach by the above-mentioned electroplating, since the above-mentioned diffusion layer is extinguished by making energization stop and growth of an electrodeposited object is suppressed, it is effective. Although it is short as much as possible in the resistance welding time and it is desirable to lengthen an energization stop time as much as possible in order to acquire a good solder plating side, such time amount (wave of a current), i.e., an energization pattern, should be taken into consideration in the range in which productivity is not reduced. So, in this invention, it is characterized by using the energization pattern in electroplating as the pattern which repeats energization of 20 or less secs, and an energization halt of 0.02 or more secs by turns.

[0023] (4) the front face after pretreatment by chemical polishing stated to one which mentioned the semiconductor package of semiconductor package this invention above (2) of leadframe material above (1) -- the conditions of description are applied and it is characterized by coming to incorporate the leadframe material to which solder plating was further performed by the solder plating approach described above (3).

[0024]

[Embodiment of the Invention] Next, 1 operation gestalt of this invention is explained. Drawing 1 shows the QFP type semiconductor package concerning 1 operation gestalt. The leadframe of the product [ agreement / 1 / among drawing ] made from a copper alloy and 2 are substrates made from a ceramic which have through hole 2a. The semi-conductor 3 and the ceramic condenser 4 are carried in the substrate 2. the film with which the leadframe 1, the semi-conductor 3, and the ceramic condenser 4 were stretched by the substrate 2 -- it connects through the conductor 5 and the bonding wire 6. The mold of the loading components to a substrate 2 and a substrate 2 is carried out with resin 7. It has exposed from resin 7 and a part of leadframe 1 is set to outer lead 1a by which a reflow is carried out at the mounting process to the circuit board which the part does not illustrate. After the mold of the resin 7 is carried out, solder plating of the outer lead 1a is carried out by electroplating.

[0025] Although a leadframe 1 is a product made from a copper alloy, the thing of the following presentation is used especially suitably.

\*\* Cr:0.04-0.4%, Zr:0.03-0.25%, and the remainder are Cu and an unescapable impurity.

\*\* 0.01 - 1.0% and the remainder are Cu and an unescapable impurity in a total amount about 1 chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4% and Zr:0.03-0.25%, or two sorts or more.

\*\* Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, Ti:0.1-0.8%, and the remainder are Cu and an unescapable impurity.

\*\* 0.01 - 1.0% and the remainder are Cu and an unescapable impurity in a total amount about 1 chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%, or two sorts or more.

[0026] Next, the procedure which carries out solder plating is explained to outer lead 1a. While carrying out chemical polishing of the front face of outer lead 1a as pretreatment of solder plating and removing an oxidizing zone, the number of the 2nd phase particles with a diameter of 1 micrometers or more which remains on a front face is made or less [ 2000 //mm ] into two. Solder plating makes an alkanol sulfonic-acid bath, an alkane sulfonic-acid bath, a HOUFUTSU-ized bath, etc. a solder plating bath, and is performed by the rack method, the conveying method, etc. The relative-velocity difference which produces the conditions of solder plating between leadframe material and plating liquid here below less than [ of a plating bath / temperature:35 degree C ], and Sn ion-concentration:25g /, and L under plating bath: They may be 2 or less m/sec. Moreover, let an energization pattern (wave of a current) be the pattern which repeats energization of 20 or less secs, and an energization halt of 0.02 or more secs by turns. If a desired solder plating layer is formed, outer lead 1a will be trimmed and a semiconductor package will be obtained.

[0027] According to the solder plating approach of this operation gestalt, by making solder plating on condition that the above, generating of the projection by the abnormality electrodeposition object is prevented, and a good solder plating layer is formed in the front face of outer lead 1a. Therefore, if it is in the semiconductor package of this operation gestalt, the short circuit by projection does not take place, but the improvement in packaging density, as a result a large miniaturization are attained as a result. Such effectiveness is promoted by using the copper alloy of a presentation of either the above-mentioned \*\* - \*\* as the ingredient of a leadframe 1.

[0028]

[Example] Next, the example which materialized this invention more is given and effectiveness of this invention is clarified more.

The copper alloy of the examples 1, 3, 5, and 7 which consist of various presentations shown in the quality table 1 of the solder plating nature by the presentation of a [trial 1] alloy, and the examples 2, 4, 6, and 8 of a comparison, and the copper alloy of the examples 9-25 which consist of various presentations shown in Table 2, and the examples 26-32 of a comparison were ingoted in the vacuum or Ar gas ambient atmosphere with the RF fusion furnace, and the ingot with a thickness of 30mm was obtained. In addition, these copper alloys used electrolytic copper or oxygen free copper as the main raw material, and used a Cu-Cr hardener, a Cu-Zr hardener, Zn and Ti, mild steel, nickel, Sn, In, Mn, Mg and Si, and a Cu-P hardener as the auxiliary material. Next, these ingots were processed in order of the process of annealing \*\* for hot working, solution treatment, the 1st cold rolling, aging treatment, the last cold rolling, and distorted removal, and were used as the plate with a thickness of 0.15mm. Then, the 50mmx150mm test piece was cut down as a sample of leadframe material from each plate.

[0029]

[Table 1]

	1) ドフレーム材 化学成分(wt%)										引張強さ (N/mm <sup>2</sup> )	導電率 (%IACS)	半田めつき性	
	Cr	Zr	Zn	Ti	Fe	Sn	Ni	Si	Mg	P	In	Mn	Cu 不純物	第2相 粒子 (nm <sup>2</sup> )
本実施例 1	—	—	0.16	—	2.24	—	—	—	0.03	—	—	—	—	1770
比較例 2	—	—	0.20	—	2.79	—	—	—	0.04	—	—	—	—	2420
本実施例 3	—	—	—	—	—	—	—	2.86	0.66	0.12	—	—	—	1210
比較例 4	—	—	—	—	—	—	3.44	0.72	0.16	—	—	—	—	2320
本実施例 5	—	—	0.28	—	—	1.22	3.05	0.65	—	—	—	—	—	1300
比較例 6	—	—	0.20	—	—	1.25	3.51	0.82	—	—	—	—	—	2600
本実施例 7	0.23	—	0.19	—	—	0.25	—	—	—	—	—	—	—	800
比較例 8	0.41	—	0.19	—	—	0.22	—	—	—	—	—	—	—	2100

[0030]  
[Table 2]

	リードフレーム材 化学成分(wt%)										第2相粒子 (mm <sup>2</sup> )				導電率 (%IACS)		半田めつき性
	Cr	Zr	Ti	Fe	Zn	Sn	Ni	Si	Mg	P	In	Mn	Ca: 不純物	引張強さ (N/mm <sup>2</sup> )			
9	0.26	0.11	—	—	—	—	—	—	—	—	—	—	—	580	90	○	
10	0.27	0.09	—	—	0.19	—	—	—	—	—	—	—	—	610	77	○	
11	0.26	0.11	—	—	—	0.29	—	—	—	—	—	—	—	630	79	○	
12	0.23	0.13	—	—	—	—	0.11	—	—	—	—	—	—	590	79	○	
13	0.22	0.17	—	—	—	—	—	—	0.21	—	—	—	—	60	570	30	○
14	0.19	0.11	—	—	—	—	—	—	—	0.08	—	—	—	65	570	76	○
15	0.19	0.12	—	—	—	—	—	—	—	—	0.02	—	—	70	590	80	○
16	0.23	0.09	—	—	—	—	—	—	—	—	—	0.05	—	80	600	80	○
17	0.22	0.16	—	—	—	—	—	—	—	—	—	0.14	—	80	620	72	○
18	0.21	0.07	0.31	0.53	—	—	—	—	—	—	—	—	—	76	670	71	○
19	0.20	0.11	0.44	0.62	—	—	—	—	—	—	—	—	—	90	690	69	○
20	0.22	0.11	0.92	0.76	0.15	—	—	—	—	—	—	—	—	90	700	88	○
21	0.21	0.07	0.84	0.59	0.55	—	—	0.24	—	—	—	—	—	95	710	68	○
22	0.18	0.12	0.88	0.77	0.80	—	—	—	—	0.04	—	—	—	85	670	67	○
23	0.19	0.13	0.32	0.46	0.54	—	—	—	—	—	0.07	—	—	90	690	66	○
24	0.21	0.14	0.32	0.44	0.44	—	—	—	—	—	0.09	—	—	95	700	68	○
25	0.23	0.07	0.37	1.10	0.19	—	—	—	—	—	—	0.14	—	85	680	69	○
26	0.21	0.29	—	—	—	—	—	—	—	—	—	—	—	2750	610	77	×
27	0.47	0.18	—	—	—	—	—	—	—	—	—	—	—	2400	590	78	×
28	0.59	0.16	—	—	0.17	—	—	—	—	—	—	—	—	3100	630	77	×
29	0.16	0.05	0.84	0.66	—	—	—	—	—	—	—	—	—	3050	710	71	×
30	0.18	0.12	0.35	1.84	—	—	—	—	—	—	—	—	—	2680	730	69	×
31	0.18	0.85	0.31	0.49	0.49	0.11	—	—	—	—	—	—	—	2400	710	68	×
32	0.24	0.11	0.49	1.95	—	—	0.16	—	—	—	—	—	—	3120	690	69	×

[0031] About each samples 1-32, after performing alkaline degreasing, 3 micrometers of surfaces were removed with chemical polishing. When the front face of each sample after chemical polishing was observed by one 1500 times the scale factor of this by SEM, since it was hard to dissolve in chemical-polishing liquid compared with the copper of a host phase, the 2nd phase particle remained in the shape of a projection. A photograph of this situation was taken for the above-mentioned scale factor, and the number of the 2nd phase particle with a diameter of 1 micrometers or more was counted on the photograph. Total observation area was made into about [ 100micrometer square ], and converted the measured number into the number per two 1mm.

[0032] Next, after the dilute sulfuric acid washed each samples 1-32 after chemical polishing 10%, solder plating was performed to each samples 1-32 on the conditions shown in Table 3. The concentration rate [ in / the solder plating bath in that case, and / in current density / 3 A/dm<sup>2</sup> and solder plating ] of Sn and Pb was set to Sn:Pb=90:10. [ an alkanol sulfonic-acid bath ] Moreover, plating time amount was made into 6 minutes, and set thickness of the plating layer formed to 7 micrometers. In addition, the agitating speed of Table 3 is equivalent to the relative-velocity difference produced between a sample and plating liquid. The front face of the solder plating layer of each samples 1-32 was observed by one 40 times the scale factor of this, the stereoscopic microscope estimated the defective (x) the case where the projection by the abnormality electrodeposition object with a height of 20 micrometers or more was accepted, and the case where it did not accept was estimated as the excellent article (O). Moreover, it reached in the tension strength per each sample 1-32, and conductivity was measured. Such evaluation results and measured value are written together to Table 1 and 2. In addition, the underline of Table 1 and 2 shows the numeric value which deviates from this invention.

[0033]

[Table 3]

めつき浴温度 (°C)	Snイオン濃度 (g/L)	搅拌速度 (m/sec)	電流波形：各サイクルの On/Off の時間 (sec)
22	24	1.5	
			10/1

[0034] The sample which consists of a copper alloy of the presentation of a, b, and c shown in Table 4 by the same approach as the quality above-mentioned trial 1 of the solder plating nature by [trial 2] solder plating conditions was obtained. By the still more nearly same approach, it reached in distribution of the 2nd phase particle of Samples a, b, and c, and tension strength, and conductivity was measured. These results are written together to Table 4.

[0035]

[Table 4]

	リードフレーム材組成(wt%)	第2相粒子個数(個/mm <sup>2</sup> )	特性
a	Cu - 2.24%Fe - 0.09%P - 0.15%Zn	1770	引張強さ : 530N/mm <sup>2</sup> 導電率 : 58%IACS
b	Cu - 2.86%Ni - 0.66%Si - 0.12%Mg	1210	引張強さ : 720N/mm <sup>2</sup> 導電率 : 51%IACS
c	Cu - 0.22%Cr - 0.08%Zr	80	引張強さ : 570N/mm <sup>2</sup> 導電率 : 81%IACS

[0036] Next, after carrying out chemical polishing of the samples a, b, and c and the dilute sulfuric acid washed 10%, solder plating was performed on the conditions shown in Table 5, and the samples 33-38 of an example and the samples 39-42 of the example of a comparison were obtained. Thickness of the solder plating bath in that case, current density, the concentration rate of Sn and Pb, plating time amount, and a plating layer was made into the same conditions as trial 1. Subsequently, the front face of the solder plating layer of each samples

33-42 which carried out solder plating was observed by one 40 times the scale factor of this with the stereoscopic microscope, and the same approach as trial 1 estimated solder plating nature. It writes together to the result table 5. In addition, also in Table 5, the numeric value shown by the underline deviates from this invention.

[0037]  
[Table 5]

リード フレーム 材	半田めつき条件				半田めつき性
	めつき浴 温度(℃)	Snイオン濃度(g/L)	搅拌速度 (m/sec)	電流波形：各サイクルの On/Off の時間 (sec)	
33 a	18	20	0.3	常時 On	○
34 a	30	23	1.0	10/0.5	○
35 b	20	22	0.4	常時 On	○
36 b	24	20	1.2	5/1	○
37 c	20	19	1.6	常時 On	○
38 c	23	20	0.4	5/2	○
39 a	20	21	2.6	常時 On	×
40 b	25	26	0.4	3/1	×
41 a	28	23	0.8	常時 On	×
42 b	24	29	0.4	30/1	×

[0038] Although the example whose number of the 2nd phase particles which remain after chemical polishing is

within the limits of this invention had good solder plating nature so that clearly [ in Table 1 and 2 showing the result of trial 1 ], the solder plating nature of the example of a comparison for which the number of the 2nd phase particles deviates from this invention is inferior, and the effectiveness of this invention was checked. Moreover, according to the table 5 showing the result of trial 2, when the temperature, Sn ion concentration, and agitating speed of a plating bath deviated from this invention especially, it was checked that solder plating nature is inferior.

[0039]

[Effect of the Invention] As explained above, according to this invention, it can prevent that the projection by the abnormality electrodeposition object occurs on the front face of the leadframe material by which solder plating was carried out, therefore the short circuit by projection is prevented, and the improvement in packaging density, as a result a large miniaturization are attained as a result.

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TECHNICAL FIELD

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[Field of the Invention] This invention relates to the approach of performing solder plating to the leadframe material and leadframe material of a semiconductor package, and the semiconductor package in which it comes to include the leadframe material to which solder plating was performed.

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PRIOR ART

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[Description of the Prior Art] The further miniaturization, thin-shape-izing, and multi-functionalization are demanded of electronic equipment, such as a portable personal computer with spread remarkable in recent years, and a cellular phone. In order to realize it, a miniaturization, high integration, and those high density mounting technology of electronic parts are needed. Since the semiconductor package which makes the nucleus of electronic parts is excellent in economical efficiency and mass-production nature, its plastic package which carried out the mold of the circuitry components, such as a semi-conductor, resistance, and a capacitor, with thermosetting resin with the leadframe is in use. SOP (small outline package), QFP (quad flat package), etc. the plastic package of whose is a surface mount device are becoming in use. Since especially QFP can respond to the increment in an I/O signal, there is much need. Moreover, CSP (chip-size package) of what promoted thin shape-ization called TSOP (Singh quad flat package) with a thickness of about 1mm, and various gestalten brought close to the size of a semiconductor chip as much as possible is also in the limelight.

[0003] By the way, the product made from a Fe-nickel system alloy to which the leadframe for energization used for various kinds of above-mentioned semiconductor packages mainly makes a nickel-Fe alloy representation 42% (mass percentage: only indicate it as % below), or the product made from a copper alloy was used. However, in recent years, compared with a Fe-nickel system alloy, conductivity is high, and the product made from a copper alloy is increasing from the field advantageous to the correspondence to the formation of high temperature stripping of a semiconductor package, or improvement in the speed of signal transduction. As the copper alloy, many precipitation-hardening mold copper alloys, such as a Cu-Fe-P system which combines high intensity and high conductivity, a Cu-nickel-Si system, a Cu-Cr system, and a Cu-Cr-Zr system, are used.

[0004] Now, in the production process of a semiconductor package, after performing resin mold, generally forming a plating layer in the front face of the outer lead (it is also called a lead terminal) which is the part which has come out of the resin mold of a leadframe by electroplating is performed. The plating processing to an outer lead is aimed at making easy corrosion resistance improvement and mounting to a substrate etc. As a plating ingredient, solder with good solder wettability is usually used. Although the melting point becomes the lowest with 183 degrees C and becomes good [ wettability ] in the eutectic presentation near 63%Sn-37%Pb, when an outer lead is drawn through, in the continuing trimming process, the degree of hardness which is extent which solder waste does not generate is required for solder. Generally from the viewpoint, the solder whose content of Sn is 80 - 90% is used.

[0005] If in charge of electroplating an outer lead, in advance of actual plating processing, chemical polishing removes the oxidizing zone of dozens produced on the surface of the outer lead with heating at the time of carrying out the cure of the resin mold - about 100nm of numbers. As a plating bath used for electroplating, solder plating baths, such as an alkanol sulfonic-acid bath, an alkane sulfonic-acid bath, and a HOUFUTSU-ized bath, are used. The rack method for hanging an outer lead on a rack, being immersed during the plating bath of a plating tub the whole rack as electroplating, and giving electroplating, the conveying method for giving electroplating, while conveying during a plating bath using the plating tub equipped with the loader and the unloader, etc. are adopted. After the semiconductor package by which solder plating was performed to the outer lead trims an outer lead, a substrate is equipped with it at the reflow process at the time of mounting.

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## EFFECT OF THE INVENTION

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[Effect of the Invention] As explained above, according to this invention, it can prevent that the projection by the abnormality electrodeposition object occurs on the front face of the leadframe material by which solder plating was carried out, therefore the short circuit by projection is prevented, and the improvement in packaging density, as a result a large miniaturization are attained as a result.

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## TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] By the way, when electroplating was given as mentioned above, there was a case where the defect dotted with the abnormality electrodeposition object of the letter of a projection on the surface of an outer lead arose, conventionally. It was presupposed that a deposit of solder was originated in being generated locally, and also when this projection deposited in the shape of resin and die length of hundreds of micrometers was reached, there was. The projection by deposit of such an abnormality electrodeposition object was what causes the short circuit of an outer lead, and the fault of incorrect actuation of the circuit further accompanying it. Recently, it can be said that there are some which made the pitch of an outer lead small to about 150 micrometers, and raised packaging density in order to meet the demand of a miniaturization of a semiconductor package, therefore the above-mentioned fault is in the situation which is easy to generate increasingly.

[0007] Therefore, this invention aims at the following matters.

\*\* Offer the leadframe material by which generating of the projection by the abnormality electrodeposition object is prevented.

\*\* In carrying out solder plating of the leadframe material, offer the solder plating approach that generating of the projection by the abnormality electrodeposition object is prevented.

\*\* There is no projection by the abnormality electrodeposition object in the leadframe material by which solder plating was carried out, and therefore the short circuit by projection is prevented, and offer the semiconductor package by which the improvement in packaging density, as a result a large miniaturization are attained as a result.

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## MEANS

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[Means for Solving the Problem] As a result of considering wholeheartedly generating of an abnormality electrodeposition object, presentation of leadframe material, and relation with solder plating conditions, this invention person etc. finds out the terms and conditions which an abnormality electrodeposition object does not generate, and came to complete this invention. Below, the concrete approach is explained.

[0009] (1) The precipitation-hardening mold copper alloy which mentioned above the leadframe material of pretreatment this invention by chemical polishing of leadframe material also a copper alloy and in it is used suitably. Such a copper alloy has many which contain in an in-house the 2nd phase particle produced according to a deposit or crystallization. As the main 2nd phase particles, Cr and a Cu-Zr compound are mentioned by Cr and the Cu-Cr-Zr system copper alloy with a nickel-Si compound and a Cu-Cr system copper alloy with a Cu-Fe-P system copper alloy at a Fe-P compound and a Cu-nickel-Si system copper alloy. Since it is hard to dissolve in chemical-polishing liquid rather than the copper of a host phase in the case of chemical polishing usually performed as pretreatment of solder plating, these particles may remain in the shape of a projection on the front face of leadframe material. When this serves as an origin when an electrodeposited object deposits and lessened [ therefore ] the 2nd phase particle, what the deposit of an electrodeposited object will be suppressed for was assumed.

[0010] Then, this invention person etc. found out that a deposit of an electrodeposited object was suppressed, when the number and the relation of a residual condition of the 2nd phase particle after chemical polishing were investigated and the number of the 2nd phase particles with a diameter of 1 micrometers or more which remains on the front face after chemical polishing was two or less [ 2000 //mm ]. Therefore, the leadframe material of this invention is leadframe material to which solder plating is performed, after consisting of a copper alloy and carrying out chemical-polishing processing of the front face, and it is characterized by making or less [ 2000 //mm ] into two the number of the 2nd phase particles with a diameter of 1 micrometers or more which remains on the front face of this leadframe material by chemical-polishing processing.

[0011] The mixed liquor of a common peroxide and an acid is used as chemical-polishing liquid used for chemical polishing. A peroxide has the operation which separates oxygen ion and oxidizes the copper of a base material, and, on the other hand, an acid has the operation which dissolves an oxide. Therefore, the surface of a copper alloy is removable with these coexistence. As a peroxide, persulfate, such as ammonium persulfate besides hydrogen peroxide solution, is used. Moreover, what has copper solubility high as an acid is desirable, for example, a sulfuric acid, a nitric acid, a hydrochloric-acid HOUFUTSU acid, sulfamic acid, etc. are used.

[0012] (2) Explain the convention about the presentation of leadframe material, next the presentation of the leadframe material of this invention, and its basis. (a) A Cu-Cr-Zr system copper alloy \*\* alloy presentation is characterized by the remainder consisting of Cu and an unescapable impurity Cr:0.04-0.4% (% said here being mass percentage and being altogether the same below) and Zr:0.03-0.25%.

[0013] If aging treatment is performed after Cr carries out solution treatment of the alloy, it will deposit in a host phase and will raise reinforcement. However, if the content of Cr cannot acquire the desired improvement effectiveness in on the strength at less than 0.04% but exceeds 0.4% on the other hand, big and rough Cr will remain in a host phase, and solder plating nature will deteriorate. Therefore, the content of Cr is made into 0.04 - 0.4%, and is desirable especially within the limits of this. [ 0.25% or less of ] Moreover, by performing aging treatment, Zr forms Cu and a compound, deposits in a base material, and raises reinforcement. However, if the content of Zr cannot acquire the desired improvement effectiveness in on the strength at less than 0.03% but exceeds 0.25% on the other hand, Zr which is not dissolved [ big and rough ] will remain in a host phase, and solder plating nature will deteriorate. Therefore, the content of Zr is made into 0.03 - 0.25%, and is desirable

especially within the limits of this. [ 0.15% or less of ]

[0014] \*\* It is characterized by the remainder consisting of Cu and an unescapable impurity 1 as which the alloy presentation was chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4% and Zr:0.03-0.25%, or two sorts or more 0.01 to 1.0% in a total amount.

[0015] The reason for a convention of the content of Cr and Zr is based on the above-mentioned (a) \*\*. Each of Zn, nickel, Sn, In, Mn, P, Mg, and Si raises reinforcement mainly by solid solution strengthening, without reducing the conductivity of an alloy greatly. Therefore, any one sort or two sorts or more are added. However, if the content cannot acquire the improvement effectiveness in on the strength of a request at a total amount at less than 0.01% but exceeds 1.0% on the other hand, conductivity will fall remarkably. Therefore, the total amount was made into 0.01 - 1.0%.

[0016] (b) A Cu-Cr-Zr-Fe-Ti system copper alloy \*\* alloy presentation is characterized by being the product made from a copper alloy which the remainder becomes from Cu and an unescapable impurity Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%.

[0017] The reason for a convention of the content of Cr and Zr is based on the above-mentioned (a) \*\*. By performing aging treatment, Fe and Ti form an intermetallic compound with that of Fe and Ti into a host phase, and raise reinforcement more by this. However, both contents cannot acquire the desired improvement effectiveness in on the strength at less than 0.1%. On the other hand, the big and rough inclusion with which the content of Fe will use Fe and Ti as a principal component if the content of 1.8% and Ti exceeds 0.8% remains, and solder plating nature is checked. Therefore, the content of Fe is made into 0.1 - 1.8%, and is desirable especially within the limits of this. [ 1.4% or less of ] Moreover, the content of Ti is made into 0.1 - 0.8%, and is desirable especially within the limits of this. [ 0.4% or less of ]

[0018] \*\* It is characterized by the remainder consisting of Cu and an unescapable impurity 1 as which the alloy presentation was chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%, or two sorts or more 0.01 to 1.0% in a total amount.

[0019] The reason for a convention of the content of Cr and Zr is based on the above-mentioned (a) \*\*. Moreover, the reason for a convention of the content of Fe and Ti is based on the above-mentioned (b) \*\*. Furthermore, 1 chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si or the reason for a convention of two or more sorts of total amounts is based on the above-mentioned (a) \*\*.

[0020] (3) In case the solder plating approach solder plating to leadframe material is performed, the temperature, the metal ion concentration, and the stirring conditions of a plating bath influence a deposit of an abnormality electrodeposition object and growth. The diffusion layer which the metal ion was consumed by the deposit reaction near the leadframe material (i.e., cathode near), and became low [ ion concentration ] in the condition of having been immersed during the plating bath in leadframe material is generating. For this reason, growth of a plating layer is influenced by the rate of the metal ion which passes this diffusion layer. Since the diffusion length of a metal ion required for generation of the electrodeposited object in the part will become short once an electrodeposited object deposits in the shape of a projection, the occurrence frequency of an electrodeposited object will increase and an electrodeposited object will grow. In order to suppress this growth, the means which lowers the migration rate of ion, the means which lowers metal ion concentration, and a means to restrict the strength [ a plating bath ] of churning and to thicken a diffusion layer are mentioned by lowering the temperature of a plating bath.

[0021] this invention person etc. found out that growth of an electrodeposited object was suppressed, when various conditions of these means were changed and investigated and the relative-velocity difference of the leadframe material and plating liquid which the temperature of a plating bath produces when Sn ion concentration under 35 degrees C or less and plating bath makes a plating bath stir below 25g / L fulfilled the terms and conditions of 2 or less m/sec. Therefore, the solder plating approach for the leadframe material of the semiconductor package of this invention is characterized by making into 2 or less m/sec the relative-velocity difference which produces Sn ion concentration under 35 degrees C or less and plating bath for the temperature of a plating bath between 25 or less g/L, leadframe material, and plating liquid as conditions for electroplating. In addition, about the temperature of a plating bath, 25 degrees C or less are more desirable, below 20g / L are more desirable about Sn ion concentration, and 1 m/sec is more desirable about a relative-velocity difference.

[0022] Moreover, in the solder plating approach by the above-mentioned electroplating, since the above-mentioned diffusion layer is extinguished by making energization stop and growth of an electrodeposited object is suppressed, it is effective. Although it is short as much as possible in the resistance welding time and it is

desirable to lengthen an energization stop time as much as possible in order to acquire a good solder plating side, such time amount (wave of a current), i.e., an energization pattern, should be taken into consideration in the range in which productivity is not reduced. So, in this invention, it is characterized by using the energization pattern in electroplating as the pattern which repeats energization of 20 or less secs, and an energization halt of 0.02 or more secs by turns.

[0023] (4) the front face after pretreatment by chemical polishing stated to one which mentioned the semiconductor package of semiconductor package this invention above (2) of leadframe material above (1) -- the conditions of description are applied and it is characterized by coming to incorporate the leadframe material to which solder plating was further performed by the solder plating approach described above (3).

[0024]

[Embodiment of the Invention] Next, 1 operation gestalt of this invention is explained. Drawing 1 shows the QFP type semiconductor package concerning 1 operation gestalt. The leadframe of the product [ agreement / 1 / among drawing ] made from a copper alloy and 2 are substrates made from a ceramic which have through hole 2a. The semi-conductor 3 and the ceramic condenser 4 are carried in the substrate 2. the film with which the leadframe 1, the semi-conductor 3, and the ceramic condenser 4 were stretched by the substrate 2 -- it connects through the conductor 5 and the bonding wire 6. The mold of the loading components to a substrate 2 and a substrate 2 is carried out with resin 7. It has exposed from resin 7 and a part of leadframe 1 is set to outer lead 1a by which a reflow is carried out at the mounting process to the circuit board which the part does not illustrate. After the mold of the resin 7 is carried out, solder plating of the outer lead 1a is carried out by electroplating.

[0025] Although a leadframe 1 is a product made from a copper alloy, the thing of the following presentation is used especially suitably.

\*\* Cr:0.04-0.4%, Zr:0.03-0.25%, and the remainder are Cu and an unescapable impurity.

\*\* 0.01 - 1.0% and the remainder are Cu and an unescapable impurity in a total amount about 1 chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4% and Zr:0.03-0.25%, or two sorts or more.

\*\* Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, Ti:0.1-0.8%, and the remainder are Cu and an unescapable impurity.

\*\* 0.01 - 1.0% and the remainder are Cu and an unescapable impurity in a total amount about 1 chosen from Zn, nickel, Sn, In, Mn, P, Mg, and Si Cr:0.04-0.4%, Zr:0.03-0.25%, Fe:0.1-1.8%, and Ti:0.1-0.8%, or two sorts or more.

[0026] Next, the procedure which carries out solder plating is explained to outer lead 1a. While carrying out chemical polishing of the front face of outer lead 1a as pretreatment of solder plating and removing an oxidizing zone, the number of the 2nd phase particles with a diameter of 1 micrometers or more which remains on a front face is made or less [ 2000 //mm ] into two. Solder plating makes an alkanol sulfonic-acid bath, an alkane sulfonic-acid bath, a HOUFUTSU-ized bath, etc. a solder plating bath, and is performed by the rack method, the conveying method, etc. The relative-velocity difference which produces the conditions of solder plating between leadframe material and plating liquid here below less than [ of a plating bath / temperature:35 degree C ], and Sn ion-concentration:25g /, and L under plating bath: They may be 2 or less m/sec. Moreover, let an energization pattern (wave of a current) be the pattern which repeats energization of 20 or less secs, and an energization halt of 0.02 or more secs by turns. If a desired solder plating layer is formed, outer lead 1a will be trimmed and a semiconductor package will be obtained.

[0027] According to the solder plating approach of this operation gestalt, by making solder plating on condition that the above, generating of the projection by the abnormality electrodeposition object is prevented, and a good solder plating layer is formed in the front face of outer lead 1a. Therefore, if it is in the semiconductor package of this operation gestalt, the short circuit by projection does not take place, but the improvement in packaging density, as a result a large miniaturization are attained as a result. Such effectiveness is promoted by using the copper alloy of a presentation of either the above-mentioned \*\* - \*\* as the ingredient of a leadframe 1.

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EXAMPLE

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[Example] Next, the example which materialized this invention more is given and effectiveness of this invention is clarified more.

The copper alloy of the examples 1, 3, 5, and 7 which consist of various presentations shown in the quality table 1 of the solder plating nature by the presentation of a [trial 1] alloy, and the examples 2, 4, 6, and 8 of a comparison, and the copper alloy of the examples 9-25 which consist of various presentations shown in Table 2, and the examples 26-32 of a comparison were ingot in the vacuum or Ar gas ambient atmosphere with the RF fusion furnace, and the ingot with a thickness of 30mm was obtained. In addition, these copper alloys used electrolytic copper or oxygen free copper as the main raw material, and used a Cu-Cr hardener, a Cu-Zr hardener, Zn and Ti, mild steel, nickel, Sn, In, Mn, Mg and Si, and a Cu-P hardener as the auxiliary material. Next, these ingots were processed in order of the process of annealing \*\* for hot working, solution treatment, the 1st cold rolling, aging treatment, the last cold rolling, and distorted removal, and were used as the plate with a thickness of 0.15mm. Then, the 50mmx150mm test piece was cut down as a sample of leadframe material from each plate.

[0029]

[Table 1]

リードフレーム材												導電率 (%IACS)	半田めつき性	
化学成分(wt%)														
	Cr	Zr	Zn	Ti	Fe	Sn	Ni	Si	Mg	P	In	Mn	Cu 不純物	第2相 粒子 (/ $\text{mm}^2$ )
本実施例 1	—	—	0.15	—	2.24	—	—	—	—	0.03	—	—	—	残
比較例 2	—	—	0.20	—	2.79	—	—	—	—	0.04	—	—	—	残 2420
本実施例 3	—	—	—	—	—	—	—	2.86	0.66	0.12	—	—	—	残 1210
比較例 4	—	—	—	—	—	—	—	3.44	0.72	0.16	—	—	—	残 2320
本実施例 5	—	—	0.28	—	—	1.22	3.05	0.65	—	—	—	—	—	残 1300
比較例 6	—	—	0.20	—	—	1.25	3.51	0.82	—	—	—	—	—	残 2600
本実施例 7	0.23	—	0.19	—	—	0.25	—	—	—	—	—	—	—	残 800
比較例 8	0.41	—	0.19	—	—	0.22	—	—	—	—	—	—	—	残 2100
														74

[0030]  
[Table 2]

リードフレーム材												第2相粒子 (1/mm <sup>2</sup> )				引張強さ (N/mm <sup>2</sup> )		導電率 (%IACS)	半田めつき性
化学成分(wt%)																			
C	Zr	Ti	Fe	Zn	Sn	Ni	Si	Mg	P	In	Mn	Cu 不純物							
9	0.25	0.11	—	—	—	—	—	—	—	—	—	70	580	80	○	○	○		
10	0.27	0.09	—	—	0.19	—	—	—	—	—	—	76	610	77	○	○	○		
11	0.25	0.11	—	—	—	0.29	—	—	—	—	—	80	630	79	○	○	○		
12	0.23	0.13	—	—	—	—	0.11	—	—	—	—	90	590	79	○	○	○		
13	0.22	0.17	—	—	—	—	—	0.21	—	—	—	60	570	80	○	○	○		
14	0.19	0.11	—	—	—	—	—	—	0.08	—	—	65	670	76	○	○	○		
15	0.19	0.12	—	—	—	—	—	—	—	0.02	—	70	590	80	○	○	○		
16	0.23	0.09	—	—	—	—	—	—	—	—	0.05	—	90	600	80	○	○	○	
17	0.22	0.16	—	—	—	—	—	—	—	—	0.14	—	80	620	72	○	○	○	
18	0.21	0.07	0.81	0.53	—	—	—	—	—	—	—	76	670	71	○	○	○		
19	0.20	0.11	0.44	0.62	—	—	—	—	—	—	—	80	690	69	○	○	○		
20	0.22	0.11	0.82	0.76	0.15	—	—	—	—	—	—	90	700	68	○	○	○		
21	0.21	0.07	0.84	0.59	0.55	—	0.24	—	—	—	—	95	710	68	○	○	○		
22	0.18	0.12	0.88	0.77	0.80	—	—	0.04	—	—	—	85	670	67	○	○	○		
23	0.19	0.13	0.32	0.46	0.54	—	—	—	0.07	—	—	80	690	66	○	○	○		
24	0.21	0.14	0.32	0.44	0.44	—	—	—	—	0.09	—	95	700	68	○	○	○		
25	0.23	0.07	0.97	1.10	0.19	—	—	—	—	0.14	—	85	680	69	○	○	○		
26	0.21	0.29	—	—	—	—	—	—	—	—	—	2750	610	77	×	×	×		
27	0.47	0.18	—	—	—	—	—	—	—	—	—	2400	590	78	×	×	×		
28	0.59	0.16	—	—	0.17	—	—	—	—	—	—	3100	630	77	×	×	×		
29	0.16	0.06	0.84	0.66	—	—	—	—	—	—	—	3050	710	71	×	×	×		
30	0.18	0.12	0.95	1.84	—	—	—	—	—	—	—	2580	780	69	×	×	×		
31	0.18	0.35	0.81	0.49	0.49	0.11	—	—	—	—	—	2400	710	68	×	×	×		
32	0.24	0.11	0.49	1.95	—	0.16	—	—	—	—	—	3120	690	68	×	×	×		

[0031] About each samples 1-32, after performing alkaline degreasing, 3 micrometers of surfaces were removed with chemical polishing. When the front face of each sample after chemical polishing was observed by one 1500 times the scale factor of this by SEM, since it was hard to dissolve in chemical-polishing liquid compared with the copper of a host phase, the 2nd phase particle remained in the shape of a projection. A photograph of this situation was taken for the above-mentioned scale factor, and the number of the 2nd phase particle with a diameter of 1 micrometers or more was counted on the photograph. Total observation area was made into about [ 100micrometer square ], and converted the measured number into the number per two 1mm.

[0032] Next, after the dilute sulfuric acid washed each samples 1-32 after chemical polishing 10%, solder plating was performed to each samples 1-32 on the conditions shown in Table 3. The concentration rate [ in / the solder plating bath in that case, and / in current density / 3 A/dm<sup>2</sup> and solder plating ] of Sn and Pb was set to Sn:Pb=90:10. [ an alkanol sulfonic-acid bath ] Moreover, plating time amount was made into 6 minutes, and set thickness of the plating layer formed to 7 micrometers. In addition, the agitating speed of Table 3 is equivalent to the relative-velocity difference produced between a sample and plating liquid. The front face of the solder plating layer of each samples 1-32 was observed by one 40 times the scale factor of this, the stereoscopic microscope estimated the defective (x) the case where the projection by the abnormality electrodeposition object with a height of 20 micrometers or more was accepted, and the case where it did not accept was estimated as the excellent article (O). Moreover, it reached in the tension strength per each sample 1-32, and conductivity was measured. Such evaluation results and measured value are written together to Table 1 and 2. In addition, the underline of Table 1 and 2 shows the numeric value which deviates from this invention.

[0033]

[Table 3]

めっき浴温度 (C)	Snイオン濃度 (g/l)	搅拌速度 (in/sec)	電流波形：各かけの On/Off の時間 (sec)
22	24	1.5	10/1

[0034] The sample which consists of a copper alloy of the presentation of a, b, and c shown in Table 4 by the same approach as the quality above-mentioned trial 1 of the solder plating nature by [trial 2] solder plating conditions was obtained. By the still more nearly same approach, it reached in distribution of the 2nd phase particle of Samples a, b, and c, and tension strength, and conductivity was measured. These results are written together to Table 4.

[0035]  
[Table 4]

	リードフリーメタル組成(wt%)	第2相粒子個数(個/mm <sup>2</sup> )	特性
a	Cu - 2.24%Fe - 0.03%P - 0.15%Zn	1770	引張強さ : 530N/mm <sup>2</sup> 導電率 : 58%IACS
b	Cu - 2.86%Ni - 0.66%Si - 0.12%Mg	1210	引張強さ : 720N/mm <sup>2</sup> 導電率 : 51%IACS
c	Cu - 0.22%Cr - 0.08%Zr	80	引張強さ : 570N/mm <sup>2</sup> 導電率 : 81%IACS

[0036] Next, after carrying out chemical polishing of the samples a, b, and c and the dilute sulfuric acid washed 10%, solder plating was performed on the conditions shown in Table 5, and the samples 33-38 of an example and the samples 39-42 of the example of a comparison were obtained. Thickness of the solder plating bath in that case, current density, the concentration rate of Sn and Pb, plating time amount, and a plating layer was made into the same conditions as trial 1. Subsequently, the front face of the solder plating layer of each samples

33-42 which carried out solder plating was observed by one 40 times the scale factor of this with the stereoscopic microscope, and the same approach as trial 1 estimated solder plating nature. It writes together to the result table 5. In addition, also in Table 5, the numeric value shown by the underline deviates from this invention.

[0037]

Table 5

リード フレーム 材	めっき浴 温度(℃)	半田めつき条件			半田めつき性
		Snイオン濃度(g/L)	搅拌速度(m/sec)	電流波形: 各サイクルの On/Offの時間(sec)	
33	a	18	20	0.3	常時 <u>On</u>
34	a	30	23	1.0	10/0.5
35	b	20	22	0.4	常時 <u>On</u>
36	b	24	20	1.2	5/1
37	c	20	19	1.5	常時 <u>On</u>
38	c	23	20	0.4	5/2
39	a	20	21	2.5	常時 <u>On</u>
40	b	25	26	0.4	3/1
41	a	28	23	0.8	常時 <u>On</u>
42	b	24	29	0.4	30/1
本実施例		比較例			

[0038] Although the example whose number of the 2nd phase particles which remain after chemical polishing is

within the limits of this invention had good solder plating nature so that clearly [ in Table 1 and 2 showing the result of trial 1 ], the solder plating nature of the example of a comparison for which the number of the 2nd phase particles deviates from this invention is inferior, and the effectiveness of this invention was checked. Moreover, according to the table 5 showing the result of trial 2, when the temperature, Sn ion concentration, and agitating speed of a plating bath deviated from this invention especially, it was checked that solder plating nature is inferior.

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[Translation done.]

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the sectional view of the semiconductor package concerning 1 operation gestalt of this invention.

[Description of Notations]

1 -- a leadframe, a 1a-- outer lead, 2 -- substrate, and 3 -- a semi-conductor, 4 -- ceramic condenser, and 5 -- film -- a conductor, 6 -- bonding wire, and 7 -- resin.

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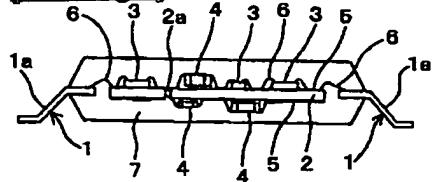
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DRAWINGS

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[Drawing 1]



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[Translation done.]